

***Operable Unit 7-08,
Organic Contamination
in the Vadose Zone
Environmental and Operational
Mid-Year Data Report, 2001***

*Ryan McMurtrey
July 2001*



*Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC*

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Mid-Year Data Report, 2001**

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**Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE Idaho Operations Office
Contract DE-AC07-99ID13727**

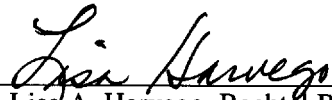
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INEEL/EXT-01-00770

Revision 0

July 2001

Approved by



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Date

ABSTRACT

Since January, 1996, Operable Unit 7-08 has been using soil vapor extraction to remove organic contamination from the vadose zone (OCVZ) beneath the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL). This document reports the operational and sample data for OCVZ recorded between January 1, 2001, and June 30, 2001. Approximately 4,375 kg (9,646 lb) of total volatile organic compounds (VOCs) were removed during this operating cycle (i.e., January 1, 2001 through June 30, 2001). Vapor Vacuum Extraction with Treatment (VVET) Units A and B removed approximately 3,469 kg (7,647 lb) and 907 kg (1,999 lb) of VOCs, respectively. During the reporting period, VVET Unit C underwent demolition and removal from the RWMC. Catalytic Oxidizer Unit D was installed and tested at the RWMC, but was not operated and thus did not contribute to the mass removal. Carbon tetrachloride is the largest contributor to the VOC mass removal with 64.8% of the total for this operating cycle. Isoconcentration plots of current CCl_4 vapor data, at approximately the 21 m (70 ft) depth, indicate an overall decrease in the areal extent of the plume when compared to data taken prior to operations at the same depth. This also suggests a decrease in the CCl_4 concentration at the center of the plume. Of the 79 replicate vapor samples collected during the rebound period, 63 pairs of samples exhibit relative percent differences of less than 30% for all analyzed components. Completeness of sampling was approximately 86%.

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ACRONYMS

DQO	data quality objective
GC	gas chromatograph
INEEL	Idaho National Engineering and Environmental Laboratory
OCVZ	organic contamination in the vadose zone
OU	operable unit
PM	preventative maintenance
RFTO	recuperative flameless thermal oxidation
RPD	relative percent difference
ROD	record of decision
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
VOC	volatile organic compound
VVET	vapor vacuum extraction with treatment

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1. INTRODUCTION

1.1 Purpose

This document reports the results of the environmental and operational organic contaminant and vadose zone vapor samples collected at the Subsurface Disposal Area (SDA) at the Idaho National Engineering and Environmental Laboratory (INEEL) during the mid-year reporting period of operations for calendar year 2001 (i.e., January 1, 2001 through June 30, 2001). The calendar year 2001 reporting period has been designated as Cycle 12. According to the *Record of Decision: Declaration for Organic Contamination in the Vadose Zone Operable Unit 7-08 (OU 7-08 ROD)* (DOE-ID 1994), the selected remedy for organic contamination in the vadose zone (OCVZ) consists of the extraction and destruction of organic contaminant vapors present in the vadose zone beneath and within the immediate vicinity of the Radioactive Waste Management Complex (RWMC), and the monitoring of vadose zone vapors and the Snake River Plain Aquifer in the vicinity of the RWMC.

To implement the selected remedy described in the OU 7-08 ROD, three vapor vacuum extraction with treatment (VVET) units with recuperative flameless thermal oxidation (RFTO) systems were installed within the boundaries of the SDA. Two of the RFTO units (designated as Units A and B) were designed to extract/treat vapors from two extraction wells, and one RFTO unit (designated as Unit C) was designed to extract/treat vapors from one extraction well. During the spring of 2001, Unit C was decommissioned and removed from the SDA and replaced with an electrically heated catalytic oxidizer (designated as Unit D) installed at the previous Unit C site. Currently, Unit A treats vapors from Extraction Well 8901D, Unit B from Well 2E, and Unit D from Well 7V.

1.2 Background

The OCVZ is designated as OU 7-08 in Waste Area Group (WAG) 7 at the INEEL. To implement the selected remedy described in the OU 7-08 ROD, which was issued final on December 2, 1994, 15 new vapor extraction and monitoring wells were installed in, or adjacent to, the SDA during 1994. In addition, one extraction well (i.e., 8901D) and five monitoring wells (i.e., D02, 8801, 8902, 9301, and 9302) were incorporated for extracting/monitoring volatile organic compound (VOC) vapors. In 2000, Wells DE-1 and M17S were installed to provide additional monitoring. Wells 6E and 7E were also installed to provide extraction capability above 80 ft below ground surface.

2. DISCUSSION OF ENVIRONMENTAL AND OPERATIONAL SAMPLE DATA

This section presents a discussion of the following data quality and monitoring objectives for the project:

- Precision
- Accuracy
- Completeness
- Comparability
- Mass Removal
- System Optimization and Maintenance
- Spatial and Temporal Distribution of VOCs in the Vadose Zone
- VVET Unit Inlet and Extraction Well Concentration Trends.

2.1 Precision

Two types of sample replicates were analyzed to ensure quality of collected data. The two classifications of replicates were field splits and field duplicates. A field split is a repeat analysis of a field-collected sample. A field duplicate is a separate sample, field collected from the same location. Precision numbers were determined by calculating the relative percent difference (RPD) for both the field duplicates and the field splits. The RPD is calculated as shown in Equation (1).

$$RPD = 100 \times \frac{(|C_1 - C_2|)}{\left(\frac{C_1 + C_2}{2}\right)} \quad (1)$$

Samples were analyzed, as in previous operating cycles, using a Brüel and Kjaer (B&K) photo-acoustic gas analyzer. Concentrations of chloroform (CHCl_3), 1,1,1-trichloroethane (TCA), tetrachloroethylene (PCE), trichloroethylene (TCE), carbon tetrachloride (CCl_4), and total VOCs were recorded (see Appendix A). A total of 79 duplicate and split sample pairs were collected during the operating cycle, resulting in a total of 395 possible component pairs. Of the 79 replicates (field duplicates + field splits) analyzed during the rebound period, 63 pairs exhibited RPDs of less than 30% for all analyzed components. The rebound period for this analysis consists of the time during which the concentrations of vapor for these replicates rebound from the low level brought about by vapor extraction to a level in equilibrium with contamination in the surrounding formation. Of the 16 sample pairs that exceeded 30% RPD, 13 were the result of measured analyte concentrations (for one or more components) below the 1 parts per million by volume (ppmv) B&K detection limit. The measurement precision decreases as sample concentrations approach the 1 ppmv detection limit of the B&K gas analyzer, resulting in the observed increase in RPD.

2.2 Accuracy

Instrument accuracy was tested using various sample standards prior to analyzing each sample set. In work conducted previously, a single 98.2 ppmv CCl₄ gas standard was used to test the performance of the B&K analyzer. A transition has now been made to incorporate the use of multiple gas standards when verifying instrument accuracy. Three standard gasses (i.e., 1.01 ppmv CCl₄, 100.5 ppmv CCl₄, and 998.77 ppmv CCl₄) have been procured and are now analyzed prior to each sample set. Analytical results for the 1.01 ppmv standard sample are consistently high, with measured concentrations ranging from 105 to 325% of the known concentration. Analytical results for 64% of the 1.01 ppmv standard sample exceed the prescribed acceptable $\pm 20\%$ error bound limit. Analytical results for the 100.5 ppmv standard sample are somewhat less scattered than those of the 1.01 ppmv standard, with results that range from 81 to 156% of the known concentration. This exceeds the prescribed acceptable $\pm 20\%$ error bound limit in 28% of the samples. Analytical accuracy drops significantly with the high concentration (998.77 ppmv) standard sample. All analytical results are below 80% of the known standard concentration. While data scatter is reduced in the analysis of the high concentration standard, a trend of under reporting the analytical data is apparent. The accuracy of the B&K instrument is illustrated in Appendix B.

2.2.1 Analytical Performance Enhancement

The B&K analytical results currently fall outside of the $\pm 20\%$ error bound limit prescribed by the *Data Quality Objectives Summary Report for the Operable Unit 7-08 Post-ROD Sampling* (OCVZ DQO report) (Bauer and Ovink 2000). Several measures have been taken to enhance the performance of analytical equipment, improve the quality of collected data, and increase the confidence with which the collected data can be used in reporting and tracking project performance.

2.2.1.1 B&K Calibration

The B&K analyzer was returned to the manufacturer for service and recalibration during the spring of 2001, at which time, the calibration range was adjusted. Standards (i.e., pre-mixed gas samples) were purchased at concentrations of 1 ppm, 100 ppm, and 1000 ppm CCl₄. Each standard was analyzed prior to analysis of monthly vapor samples to confirm the performance of the B&K analyzer across the calibration range. The results of the B&K analysis did not reflect the known calibration gas concentration. An unsuccessful effort was made to analyze the calibration gasses on a gas chromatograph (GC). Ultimately, the gasses were returned to the supplier and replaced. As a result, the B&K analysis results were not improved with this change. A review of the B&K calibration performed in the spring of 2001 revealed that the manufacturer had incorrectly adjusted the calibration range. The correct range has been identified and the B&K analyzers will be returned to the manufacturer for recalibration.

2.2.1.2 Quality Assurance

Analysis of selected samples on a GC will be completed to satisfy the quality assurance requirements set forth in the OCVZ DQO report (Bauer and Ovink 2000). A GC has been obtained that will be dedicated to the analysis of samples generated through OCVZ operations. Samples analyzed using the B&K analyzer will be repeated on the GC to confirm the VOC concentration at a rate of 1 quality assurance sample per 20 samples collected and analyzed.

2.3 Completeness

A total of 666 vapor samples, including 36 duplicates, were targeted for collection during the past 6 months of operation. Ultimately, 575 samples were collected, including 34 duplicates. Splits were targeted for analysis at a rate of 1:10, for a total target of 67 splits to be analyzed during the monthly sampling events. Percent completeness of the sampling and analytical data was calculated for this operating cycle using Equation (2). Completeness of sampling is detailed in Table 1 for monthly, duplicate, and repeat samples.

$$\%Complete = 100 \times \frac{\# \text{ Samples Collected}}{\# \text{ Samples Targeted}} \quad (2)$$

Table 1. Completeness of sampling.

	Samples Targeted	Samples Collected	Percent Complete
Monthly Samples	666	575	86.3% ^a
Monthly Duplicates	36	34	94.4%
Monthly Splits (Repeats)	67	45	67.2%

a. 4% of the wells scheduled for sampling were locked and inaccessible.

2.4 Comparability

The data set included in this report is comparable to that of previous operating cycles because the same field collection and sample handling methods were followed and identical field and quality assurance/quality control procedures were applied. Analytical detection limits are identical because the same field instrumentation was used. Duplicate field samples were targeted for collection at a rate of roughly 5%, while field splits were targeted at a rate of 10%, per the OCVZ DQO report (Bauer and Ovink 2000).

2.5 Mass Removal

The VOC concentrations between sampling events were averaged and approximately 4,375 kg (9,646 lb) of total VOCs was removed during this operating cycle. Units A and B removed approximately 3,469 kg (7,647 lb) and 907 kg (1,999 lb), respectively. Time between sampling events and the actual operating hours from operation logs were used to calculate mass removal, rather than a straight 24-hour time frame. Average daily unit operations parameters (i.e., flow rate, pressure, and temperature) were used for the mass removal calculations.

Tables C-1 and C-2 of Appendix C present the actual mass contribution to the total VOC mass removal for each of the individual analytes removed during the mid-year 2001 reporting period. Figures C-1 and C-2 also present the inlet CCl₄ concentrations to Units A and B during this reporting period. Figure C-3 presents the contribution of each VOC constituent to the total mass removal that took place during the mid-year 2001 reporting period. Figure C-4 presents the cumulative mass contribution to the total VOC mass removed for each of the analytes. Table C-3 provides a breakdown (per operating cycle) of the mass of contaminant removed to date. As can be seen, CCl₄ is the largest contributor to the VOC mass removal with 64% of the total for the mid-year 2001 reporting period (i.e., Cycle 12) and 65% overall.

2.6 System Optimization and Maintenance

Few mechanical modifications to Units A and B have been completed during the mid-year 2001 operations. A large effort was undertaken to revise and update standard operating procedures to reflect current system configuration and document requirements. Preventative maintenance (PM) activities were completed according to a previously developed PM schedule. Several minor system failures occurred and were corrected. Unit D catalytic oxidizer installation and testing was completed during the mid-year operations period.

2.6.1 Procedure Revision

Each of the Thermatrix oxidizers (Units A and B) is started up and shut down per TPR-1628, “VVET Unit Startup, Operations, and Shutdown.” This procedure was completely rewritten to ensure conformance with current INEEL standards for procedure format and content. The rewrite, in essence, divided the thermal oxidizers into several independent subsystems (e.g., compressed air and propane) and directed the startup of each. Prerequisites for each sub-system startup, along with additional safety measures, were included in the revision.

Operation and test procedures TPR-1662, “VVET Catalytic Oxidizer Startup, Operation, and Shutdown,” and TPR-1764, “VVET Catalytic Unit Integrated Test,” have been developed and executed for the Unit D catalytic oxidizer.

2.6.2 Vacuum Relief Valve

Following installation of DeZurik ball valves on Units A and B, orifice plates were removed to allow optimal system performance. The orifice plates were installed in series with the butterfly valve first, pressure relief valve second, orifice plate third, and finally the low pressure side of the vacuum blower. In this configuration, a large portion of the total system pressure drop was taken across the orifice. The pressure relief valve was only exposed to a fraction of the total vacuum pressure. The relief valve was set to cycle (i.e., function) at a vacuum pressure of 11 in. mercury, and was observed to cycle only when the butterfly valve was completely closed. Once the orifice plates were removed, the relief valve was exposed to the full system vacuum pressure at all times and was observed to cycle continuously. The relief valve was subsequently replaced with one set of valves to cycle at 14 in. mercury, correcting the problem.

2.6.3 Propane Vaporizer

During startup of Unit B, difficulty was encountered in lighting the propane vaporizer. After several attempts, the technicians were unable to bring the vaporizer online. Suburban Propane, owner of the vaporizer, was contacted and service of the vaporizer was requested. Low-level radioactive contamination was found on the vaporizer and an investigation was conducted to determine the source of the contamination. Analytical results indicated that the contaminants detected were of natural origin (i.e., present in the propane), and the propane unit was released to Suburban Propane for service. Following service, the vaporizer was re-installed and was started without further difficulty.

2.6.4 Thermocouple Failure

Failure of thermocouples caused unplanned downtime in the Unit A and Unit B oxidizers during Cycle 12. Standardized work packages are being developed to cover the replacement of the thermocouples. To minimize the occurrence of these failures in the future, all elements will be replaced at approximately 1-to 1.5-year intervals.

2.6.5 Blower Overload

When delivered to the INEEL in 1996, the blower motor overload on Unit B was set at 40 amps. Attempts to maximize vapor flow from Well 2E resulted in increased vacuum pressure and the blower overload was observed to cycle after less than 24 hours of continuous operation, resulting in system shutdown. The overload setting was adjusted to 48 amps (the nameplate capacity of the blower motor), which corrected the problem. A replacement overload has also been procured.

2.6.6 Unit D Procurement/Acceptance

A catalytic oxidation system has been purchased from King, Buck Technology of San Diego, California. This system, designated Unit D, has been installed at the SDA and tested following TPR-1764, "VVET Catalytic Unit Integrated Test." Project documentation, including safety analysis, testing and operating procedures, and a technician qualification program, has been developed, reviewed, approved, and released for use. A prefinal inspection will be conducted by the Idaho Department of Environmental Quality, Environmental Protection Agency, and Department of Energy prior to full-scale operation.

2.6.7 Preventative Maintenance

A PM schedule has been developed to ensure that appropriate measures are taken to maximize the lifetime of system components. The PM schedule identifies maintenance activities to be completed on monthly, quarterly, semi-annual, annual, and biannual intervals. The PM schedule structures work so that it can be planned by project personnel and executed by RWMC craft personnel. Development and implementation of the PM work packages are in conformance with STD-101, "Integrated Work Control Process."

2.6.8 Configuration Management

The configuration management database has been updated to reflect the as-built Thermatrix units. All significant components of the Unit D oxidation system have been added to the configuration management database. The configuration management process provides quick access to a database of information regarding individual components and pieces of equipment, including the manufacturer model and serial numbers, contact address and phone numbers, and all pertinent information for repairing or replacing any component or part thereof. It also provides a numbering system to identify the equipment/components in the field when performing PM or other work activities.

2.6.9 Calibration Program

A calibration program has been developed to ensure that process indicators, including switches, gauges, transducers, and controllers, are properly functioning. In support of the program, gauges, switches, and transducers are tested and calibrated. Calibrated instruments are retained in controlled storage at the RWMC until installation. Removal and installation of calibrated instruments is planned and executed by RWMC personnel during scheduled PM activities. This calibration program constitutes conformance of OCVZ to MCP-2391, "Calibration Program."

2.6.10 Operations and Maintenance Plan

The *Operations and Maintenance Plan for Operable Unit 7-08, Organic Contamination in the Vadose Zone* (McMurtrey and Harvego 2001) has been completely revised to include the details of operation of the catalytic and thermal oxidation systems. References to operations and maintenance of Unit C have been removed. The revised plan includes conducting manufacturer recommended maintenance activities to maximize component lifetime and minimize unplanned downtime. The plan

identifies instrument calibration intervals and PM schedules. Standard operating and test procedures for each of the unit types (i.e., thermal and catalytic), as well as technician training plans and qualification checklists, are included.

2.7 Spatial and Temporal Distribution of VOCs in the Vadose Zone

Appendix D contains figures representing a horizontal cross-section of the distribution of CCl_4 in the SDA. Concentration values were plotted for two specific days: (1) before starting the remedial action on January 4, 1996, and (2) at the end of the mid-year 2001 operating period on July 3, 2001. The CCl_4 concentration distribution was kriged^a by using the Groundwater Modeling System (GMS) software program. Plots of current CCl_4 vapor data, at approximately the 21 m (70 ft) depth, indicate an overall decrease in the areal extent of the plume when compared to data taken prior to operations at the same depth. The vapor data also indicate a decrease in the CCl_4 concentration at the center of the plume.

2.8 VVET Unit Inlet and Extraction Well Concentration Trends

Analysis of FY-00 rebound data and its implications to normal operating practices has been completed. The data indicate an increase in CCl_4 and total VOC vapor concentrations sampled in the proximity of Units A and B. The time it took to reach equilibrium cannot be conclusively determined from the collected data at present. In nearly all cases, the concentration results from before the system shutdown on June 21, 2000 rebounded in excess of 100% within 30 days of the start of the shutdown.

Figure 1 illustrates the concentration of CCl_4 in vapor ports sampled in the proximity of Unit A prior to shutdown, during rebound, and immediately following unit restart.

Before Unit A shutdown on June 21, 2000, the CCl_4 vapor concentrations at Vapor Ports 9301-6 and 9302-6 (at the 77 ft level) were 340 ppmv and 2.5 ppmv, respectively. By July 24, 2000, the CCl_4 vapor concentration at Port 9301-6 had rebounded in excess of 326% to 1,450 ppmv. Similarly, the CCl_4 concentration at Port 9302-6 increased from 2.5 ppmv (prior to shutdown) to 5.29 ppmv (112% increase) by July 13, 2000, and continued to increase through September 7, 2000, to 6.7 ppmv (168% total increase) after the restart of Unit A.

Figure 2 illustrates the CCl_4 concentrations at Ports 2E-2 (52.5 ft) and 2E-1 (87.5 ft). During the time this data was taken, Unit B was extracting from Well 2E between 80 ft and 100 ft below land surface. Unit B was shutdown on June 21, 2000, and was not restarted until April 26, 2001. At the start of the rebound period on June 22, 2000, the concentration at Port 2E-2 was 36.3 ppmv. By August 18, 2000, the concentration had increased 135% to 85.3 ppmv, and continued to increase through April 3, 2001, to a maximum of 431 ppmv (1000% increase). The most significant observed increase in concentration occurred at Port 2E-1. At the start of the rebound period (i.e., June 22, 2000), the concentration at Port 2E-1 was 0.748 ppmv, increased 687 fold to 515 ppmv by August 18, 2001, and continued to increase to 2,200 ppmv (a 2,940-fold increase) by February 5, 2001.

a. Kriging is a method of linear regression that takes into account the spatial relationship of a series of points. In this case, concentrations are estimated between actual measured data points, providing insight into what the actual concentration profile might look like at any horizontal level in the contamination zone.

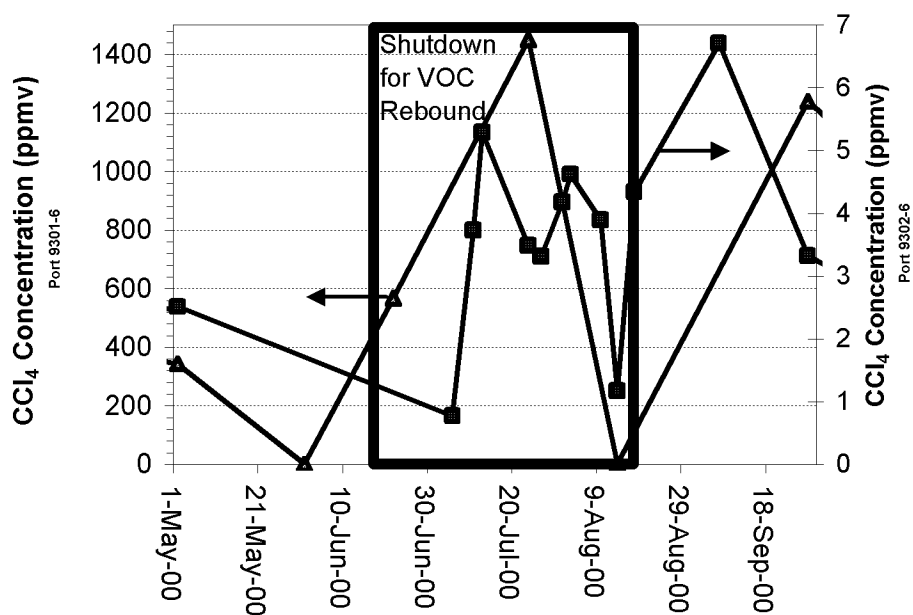


Figure 1. Rebound vapor sampling in proximity of Unit A.

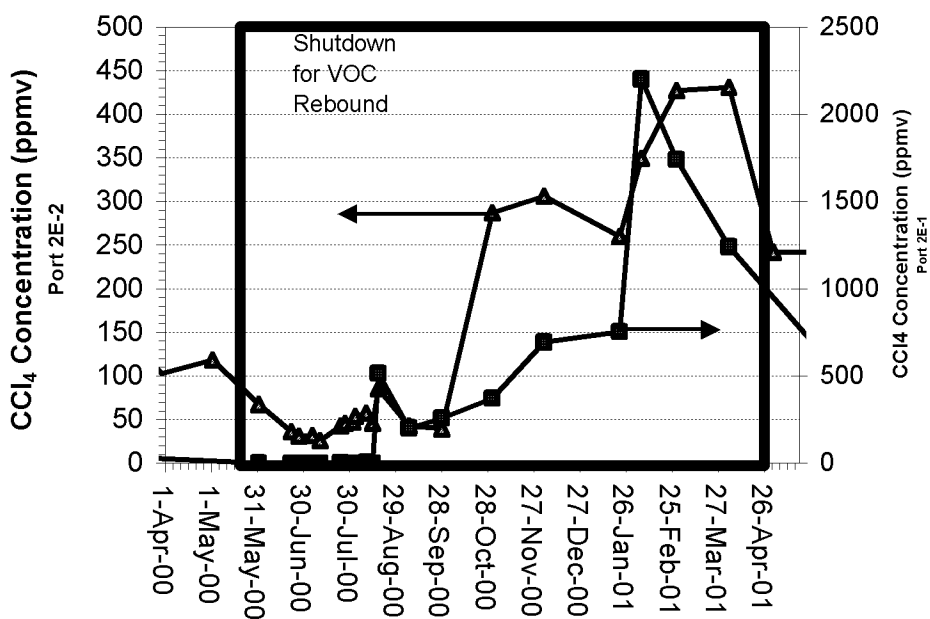


Figure 2. Rebound vapor sampling in proximity of Unit B.

The inlet concentration to each of the oxidation systems (i.e., Units A and B) is closely tied to the concentration of VOC vapor in the immediate proximity of the extraction well. An increase in vapor concentration in the proximity of an extraction well also increases the concentration of feed to the oxidizer. This enhances the economics of the remediation project by reducing the cost associated with the destruction of each pound of VOCs. Figure 3 illustrates the CCl_4 feed concentration history for Units A and B (see Appendix C). As seen in the figure, the feed concentration to each unit increases as a result of the rebound and decreases subsequent to unit startup. The CCl_4 concentration at Unit A was 61.4 ppmv on June 19, 2000, two days prior to shutdown for rebound. Immediately after restart on August 24, 2000, the inlet concentration had increased slightly to 77.1 ppmv. Then, during another extended shutdown period lasting from January 17, 2001, until March 15, 2001, the concentration increased significantly from 181 ppmv (shutdown) to 709 ppmv (restart). After restart, concentrations began to decay rapidly down to 78.1 ppmv by June 20, 2001.

A similar trend is observed in Unit B inlet samples. When Unit B was shutdown on May 18, 2000, the inlet concentration was 16.3 ppmv. Upon restart on April 27, 2001, the inlet concentration had increased to 692 ppmv. Concentrations then began to decay rapidly and reached 191 ppmv on May 5, 2001. By June 21, 2001, the CCl_4 inlet concentration had reached 129 ppmv.

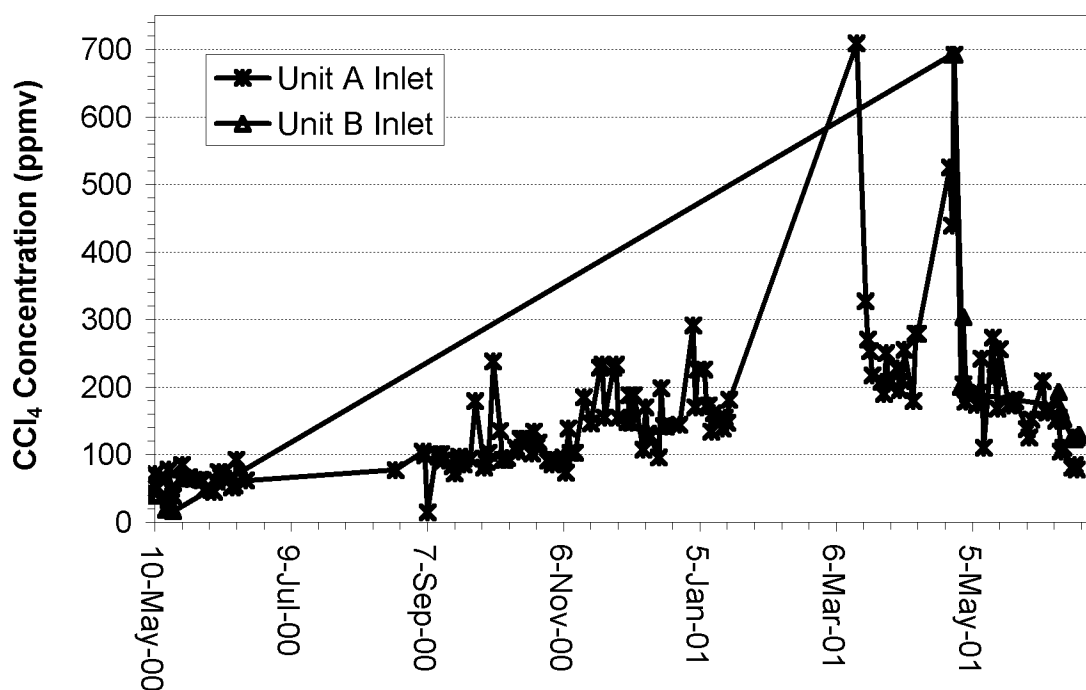


Figure 3. Inlet CCl_4 vapor concentration histories for Units A and B.

2.9 Kriging of Monthly Sample Data

Kriging diagrams have been constructed to estimate the distribution of CCl_4 in the SDA using monthly vapor samples. Each diagram constitutes a horizontal cross section of the SDA at approximately 70 ft below ground surface on a specific date. Data locations on the following figures are indicated by use of the well name the samples were taken from. Figure 4 illustrates the distribution of CCl_4 at the 70-ft level on December 4, 2000. Areas of high contaminant concentration are centered around Well 8901D (connected to Unit A) and Well 2E (connected to Unit B). The peak CCl_4 concentration around these two areas was approximately 1,800 ppmv. By February 5, 2001, the peak concentration had been reduced to approximately 1,000 ppmv in the proximity of Well 8901D and had increased to approximately 1,000 ppmv at Well 2E, as illustrated in Figure 5. Because Unit A had recently been operating and Unit B had been shut down for several months, Figure 6 illustrates the contaminant distribution after restart and operation of both Units A and B on April 3, 2001. Contaminant concentrations measured on April 3, 2001 were reduced to levels below 250 ppmv at 70 ft.

In Figure 7, vapor data collected on April 3, 2001 is plotted with a reduced scale to illustrate the distribution of the contaminant plume at reduced contaminant levels resulting from ongoing VOC removal. The maximum scale concentration in Figure 7 is 250 ppmv, while that in Figure 6 is 1,800 ppmv. Identical data are represented in both figures, only the scale is changed. Figure 8 illustrates the CCl_4 concentration and distribution in the SDA as of July 3, 2001. Continued concentration reduction between April 3, 2001, and July 3, 2001, is evident through comparison of Figures 7 and 8.

These Kriging diagrams, in conjunction with operational samples (see Figure 3), indicate that significant decreases in subsurface concentrations occurred as a result of VVET unit operations. In addition, the figures suggest that shutdown of the extraction systems, as a result of low VOC concentrations (for rebound cycling), would enhance the efficiency of the remediation process. Complete VOC concentration data, including sample port locations and depths, are collected in the *Volatile Organic Compound Vapor Monitoring Results from Selected Wells at the Radioactive Waste Management Complex* (Housley 2001) and updated annually with supplements.

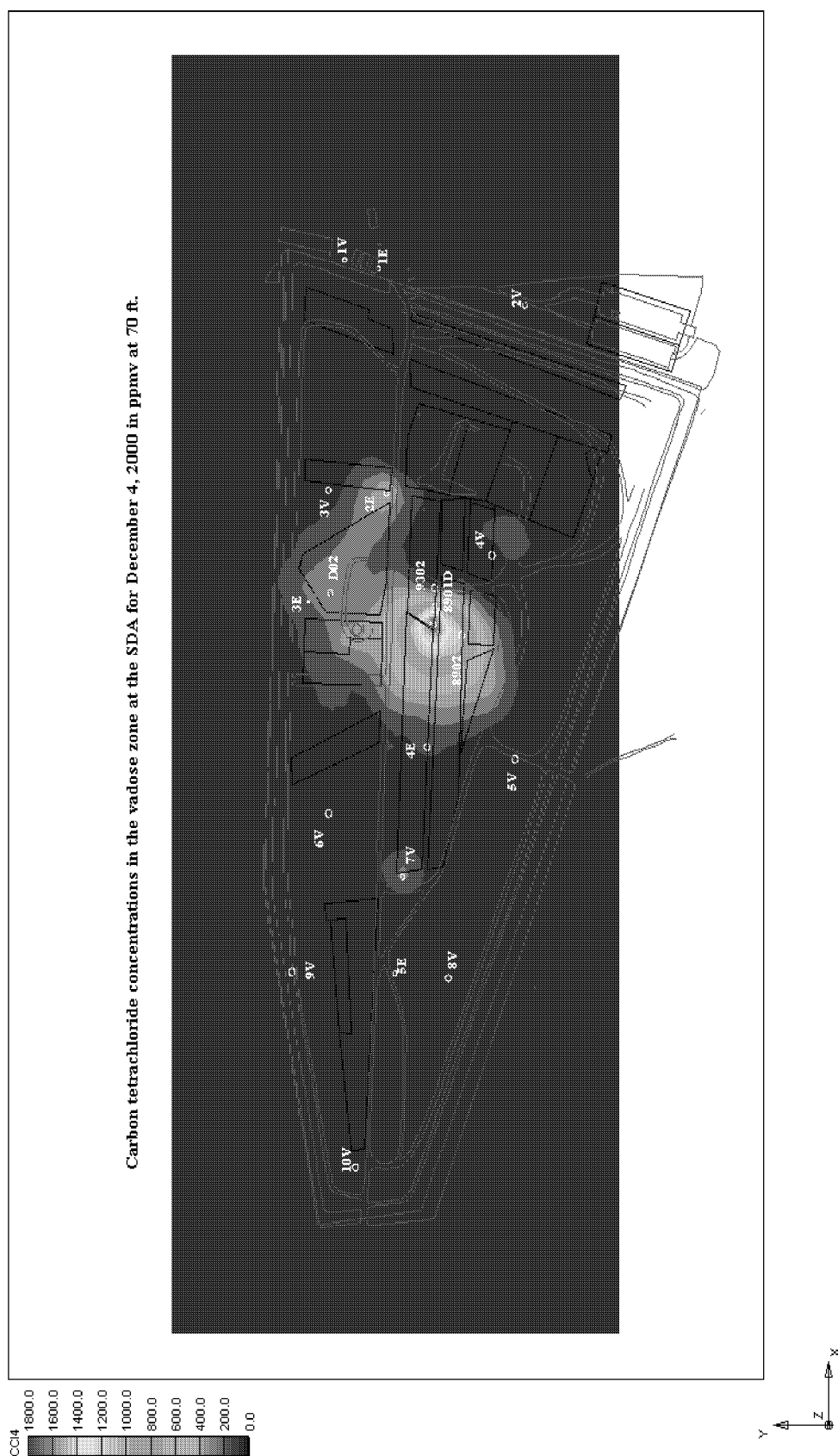


Figure 4. Carbon tetrachloride distribution in the Subsurface Disposal Area at approximately 70 ft below land surface on December 4, 2000 (1,800-ppmv scale).

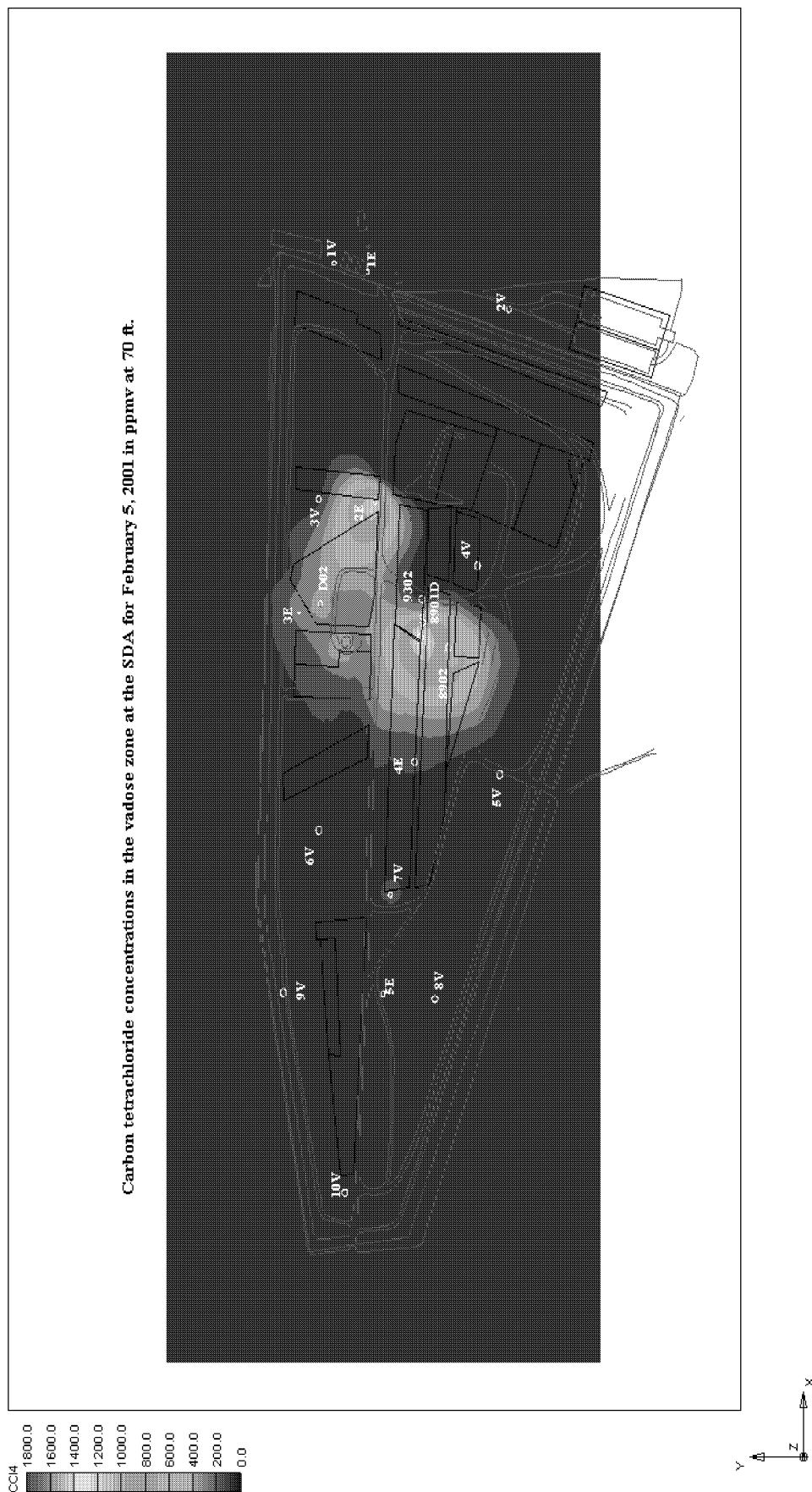


Figure 5. Carbon tetrachloride distribution in the Subsurface Disposal Area at approximately 70 ft below land surface on February 5, 2001 (1,800-ppmv scale).

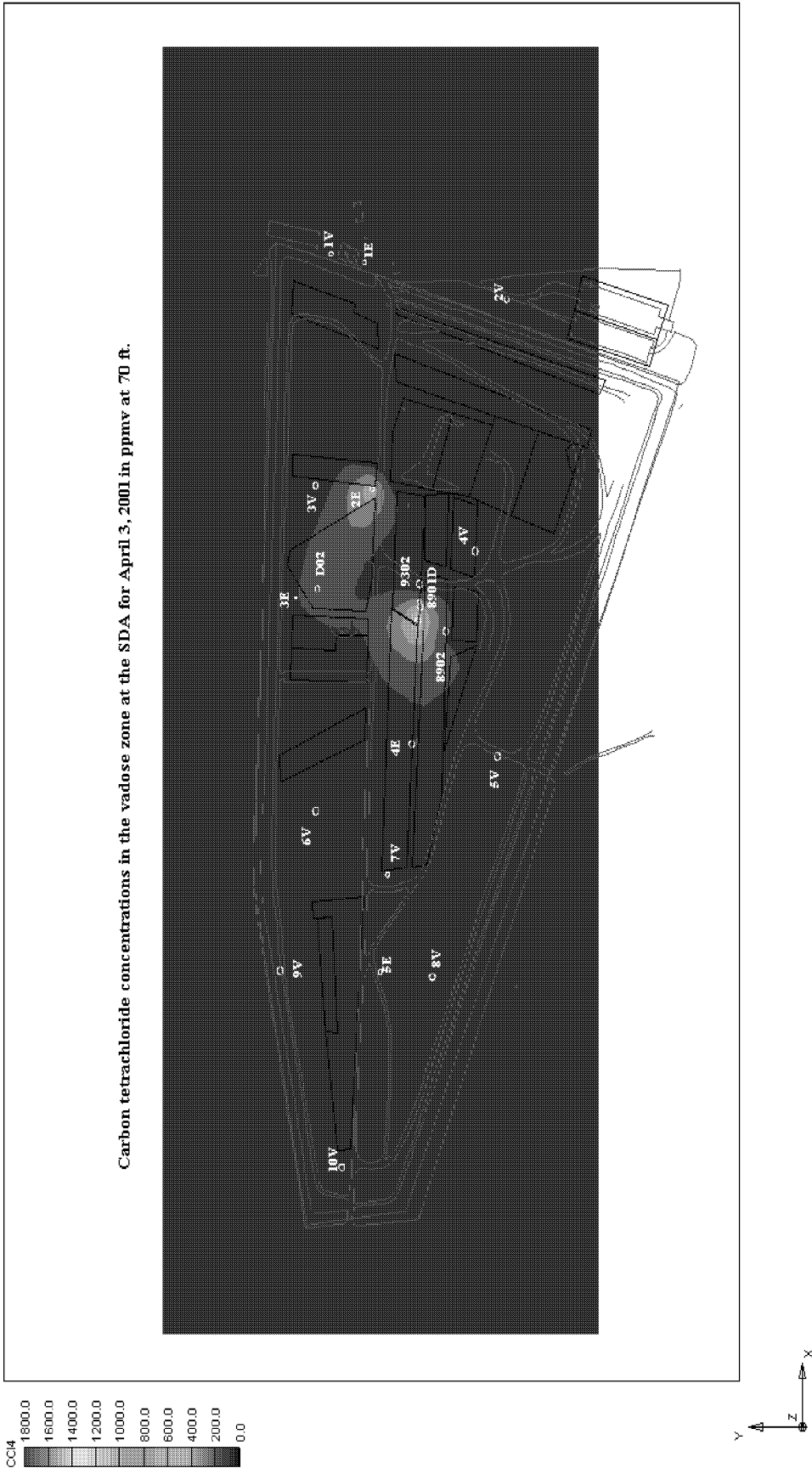


Figure 6. Carbon tetrachloride distribution in the Subsurface Disposal Area at approximately 70 ft below land surface on April 3, 2001 (1,800-ppmv scale).

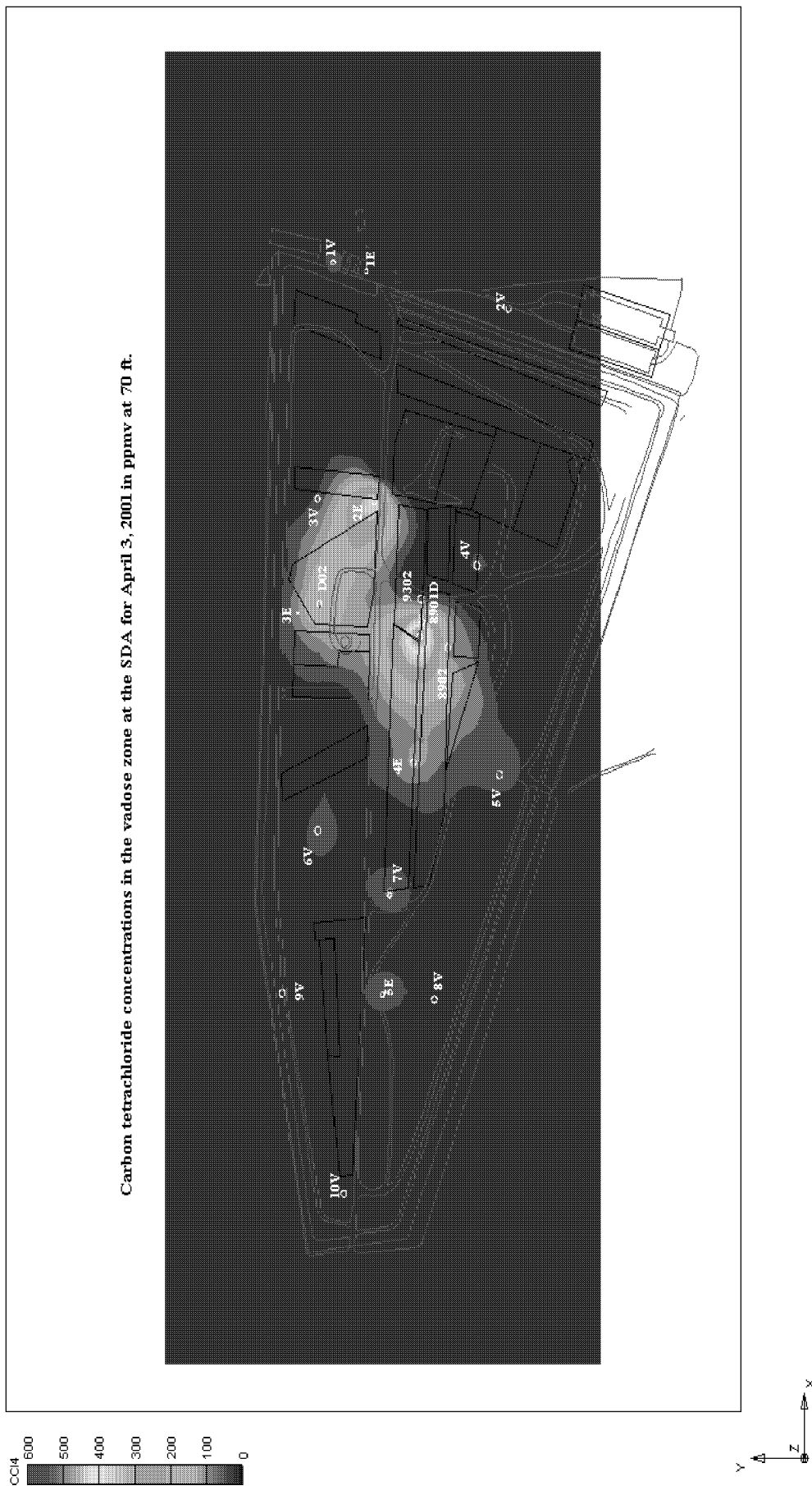


Figure 7. Carbon tetrachloride distribution in the Subsurface Disposal Area at approximately 70 ft below land surface on April 3, 2001 (250-ppmv scale).

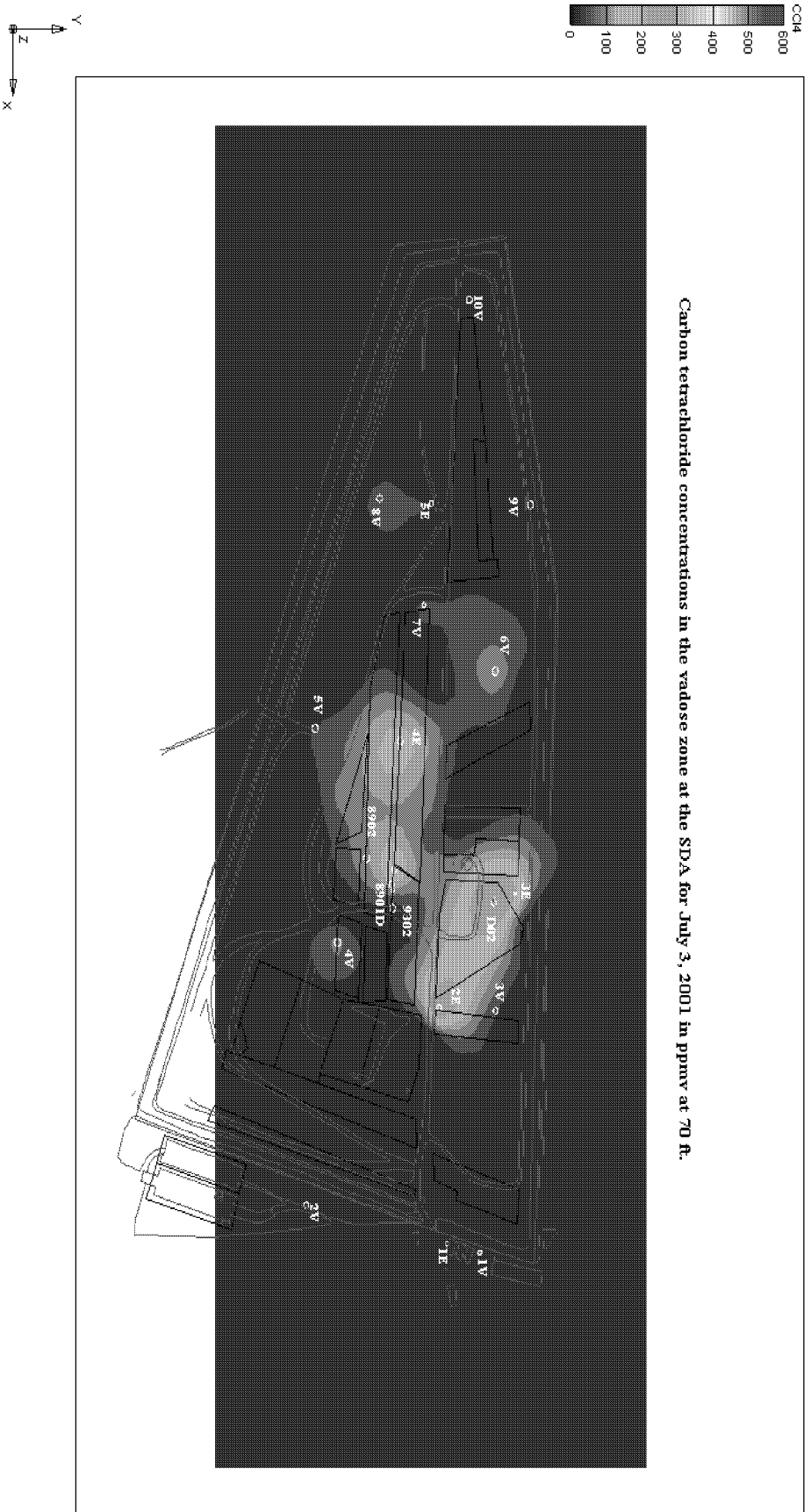


Figure 8. Carbon tetrachloride distribution in the Subsurface Disposal Area at approximately 70 ft below land surface on July 3, 2001 (250-ppmv scale).

3. CONCLUSION

The data quality and monitoring objectives outlined in the OCVZ DQO report (Bauer and Ovink 2000) were generally met for this project. To date, Units A, B, and D are operating and removing VOC mass from the RWMC subsurface. According to samples collected from various locations around the SDA, and as illustrated in Figures 4 through 8, VOC concentrations are decreasing above the 34-m (110 ft) interbed.

4. REFERENCES

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